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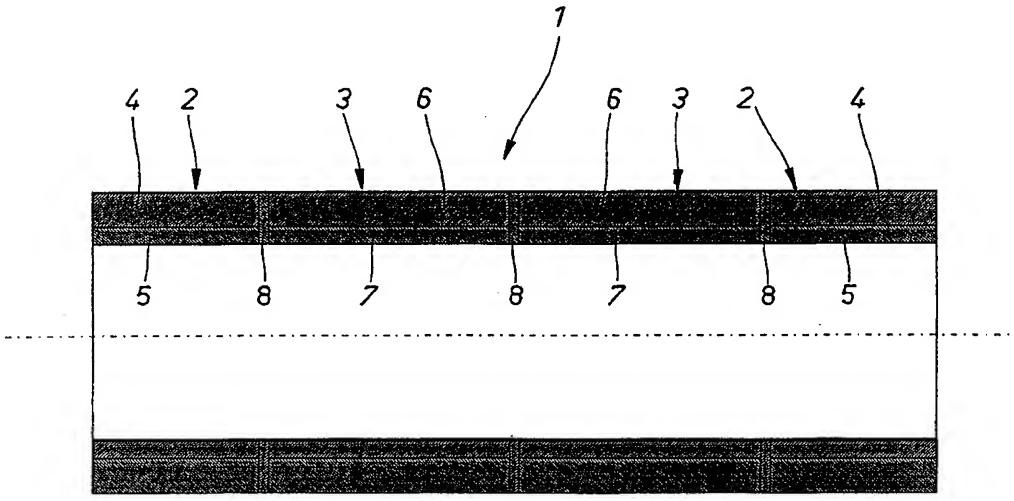

(57) Abstract

The invention relates to a roll for a paper/board or finishing machine, which is provided with a metal–constructed shell (1). In a roll of the invention, the shell (1) is designed as a composite structure, comprising in the axial direction of the shell at least two components (2, 3) manufactured respectively from a first and a second material, said first and second materials being metals different from each other in terms of the production technique and/or composition thereof, and/or in the depthwise direction of the shell, at least over a portion of the axial length of the shell, at least two layers (4, 5; 6, 7) in which the materials of a first and a second layer, respectively, are metals different from each other in terms of the production technique and/or composition thereof. The invention relates further to a method for manufacturing a roll for a paper/board or finishing machine.

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ROLL FOR A PAPER/BOARD OR FINISHING MACHINE AND METHOD FOR MANUFACTURING A ROLL SHELL

The present invention relates to a roll for a paper/board or converting or finishing machine, which is provided with a metal-constructed shell. The invention relates further to a method for manufacturing a roll shell for a paper/board or finishing machine. The roll involving the invention can be e.g. a suction roll or a deflection compensated roll.

The suction roll is used for dewatering a paper web, as well as for carrying a web onto another roll or between various assemblies. In a paper machine, the environment comprises a web forming section (a.o. a former roll and other suction rolls included in a wire section) or a press section. Examples of the disposition of suction rolls in a paper machine environment are depicted in fig. 1 to be described in more detail hereinafter, wherein reference numeral I designates a wire section, reference numeral II a press section, and reference numeral III a drying section.

In suction roll, a perforated shell is rotating as a result of being journalled upon flanged axles. The shell may house a single- or multi-compartment vacuum box, provided with apertures which are defined by sealing strips and open into the inner shell surface for focusing the vacuum on a given sector of the suction roll. The roll may also have an empty interior for applying a vacuum over the entire circumference of the shell. The roll ends are provided with connectors for turning on an external negative pressure in the vacuum box and/or the roll interior. With the negative pressure turned on, a vacuum develops underneath the paper web through a wire or a felt. The resulting pressure difference removes water from the web into the shell perforations or holds the web intact during a transfer. The negative pressure in the compartments is defined according to an intended application of the suction roll. Figs. 2 and 3 depict schematically a few suction roll designs according to the prior art.

In use, the shell of a suction roll is exposed to major dynamic loads, mechanical stresses, corrosion and wear, which, among other things, cause stress corrosion,

corrosion fatigue, and thermal fatigue, resulting in all sorts of damage in the shell. The shells of suction rolls are typically provided with about 500.000 suction holes, which contributes to further problems in terms of strength. Therefore, in demanding applications, e.g. as a counter roll for a long nip, it is necessary to employ highly sophisticated materials, e.g. powder metallurgical, which are relatively expensive.

The deflection-compensated roll, wherein a roll shell rotating around a stationary axle is supported on the axle by means of hydraulic loading elements, is used, e.g. as a press roll for a press section, as a calender roll, or as a breast roll for a wire section. The hydraulic loading elements work in nip rolls in the direction of a nip plane and can be used for regulating the roll shell in terms of its shape and for controlling the roll in terms of its axial nip profile. The nip profile control is implemented in terms of zones, the number of zones being typically e.g. 6 to 10, each provided with a number of loading elements, but the zone division can also be effected in such a way that each zone is only provided with a single loading element, whereby the number of zones can be even more than 60.

One object of the present invention is to provide a novel type of suction roll, wherein a material superior in terms of its qualities, e.g. a material possessing a superior corrosion fatigue strength or an improved thermal fatigue resistance, can be used exclusively in those parts of a metal-constructed shell in which such above-discussed qualities are required. As for deflection compensated rolls, one objective is to develop roll shells thinner than the available ones for an improved controllability over the nip profile and, at the same time, for a reduced mass, which in turn contributes to the damping of vibrations. In order to achieve these objectives, a roll of the invention is characterized in that the shell is designed as a composite structure, comprising in the axial direction of the shell at least two components manufactured respectively from a first and a second material, which are metals different from each other in terms of the production technique and/or composition thereof, and/or in the depthwise direction of the shell, at least over a portion of the axial length of the shell, at least two layers in which the materials of a first and a second layer, respectively,

are metals different from each other in terms of the production technique and/or composition thereof.

In a first aspect, a method of the invention for manufacturing a roll shell is characterized in that the method comprises manufacturing at least two components in the axial direction of the shell from a first and a second material, respectively, said materials being metals different from each other in terms of the production technique and/or composition thereof and being assembled into a roll shell by connecting the components together at the ends thereof. The connection is preferably made by welding.

In a second aspect, a method of the invention for manufacturing a roll shell is characterized in that the method comprises manufacturing at least one axial component from a first material and providing its inner and/or outer surface with a structural layer of a second material, said materials being metals different from each other in terms of the production technique and/or composition thereof.

In a third aspect, a method of the invention for manufacturing a suction roll shell is characterized in that the method comprises manufacturing an axial mid-section from a first material and providing its inner and/or outer surface with a structural layer of a second material, as well as end sections from a third material, whose inner and/or outer surface is optionally provided with a structural layer of a fourth material, said first and second materials and, respectively, said third and fourth materials being metals different from each other in terms of the production technique and/or composition thereof, and assembling a suction roll shell by connecting the axial mid-section to the end sections. The second and fourth materials, which constitute said structural layers, are preferably made of an identical metal material.

In suction roll, the stresses lessen towards the ends of a roll, whereby, according to the invention, the ends of a roll shell can be made of a first material which is relatively less expensive and those can be welded, e.g. by means of electron beam welding, to a mid-section made of a second, higher-quality material. The

first material may comprise for example austenitic-ferritic stainless steel, generally known as stainless duplex steel or just duplex steel. The production of such a material is done by using traditional techniques, e.g. forging, milling or casting. The second material used in a more demanding object, the mid-section of a roll, comprises for example powdered metal. The term powdered metal refers to a metal in the form of spherical particles, made from a molten metal by means of gas-atomization and having a particle diameter in the order of 0,1 to 0,5 mm. It may be higher-alloyed than steel types produced by traditional methods. The production of a powdered metal is carried out by using powder metallurgical processes, including e.g. injection, extrusion, and hot-isostatic pressing (HIP). In the HIP method, for example, a piece of metal assumes its final shape and density under a high pressure and temperature while the metal is nonetheless in a non-molten state, the qualities obtainable for a product being higher and more homogeneous than those obtained by molten methods. The first and second materials will have a material composition which is naturally selected in such a way that the machining and heat treatment properties are sufficiently close to each other. As for the chemical composition thereof, the first and second materials can be identical to or different from each other. The higher qualities of the second material are obtained by virtue of a non-melting production technique.

The roll shell of the invention can also be designed as a composite structure in such a manner that it comprises at least two layers depthwise of the shell, a first material layer and a second material layer. The first material layer is manufactured in traditional methods from a sheet by milling or forging. The second material layer is formed on the inner or outer surface of the first material layer by powder metallurgical methods. For example, when using the HIP method, the layer of powdered metal can be produced on the inner surface of a segment made of the first material, said segment of the first material functioning as a mould. The layer of powdered metal is capable of providing the shell with desirable extra features in desired places. As for the chemical composition thereof, the first and second materials can be identical to or different from each other. The higher qualities of the second material are obtained by virtue of a non-melting production technique.

The roll shell of the invention can also be designed as a composite structure in such a manner that it comprises an axial mid-section of a first material, having its inner and/or outer surface provided with a structural layer of a second material, as well as end sections of a third material, having its inner and/or outer surface optionally provided with a structural layer of a fourth material, said first and second materials and, respectively, said third and fourth materials being metals different from each other in terms of the production technique and/or composition thereof, said suction roll shell being assembled by connecting the axial mid-section to the end sections, preferably by welding. The second and fourth materials constituting said structural layers are preferably made of an identical metal material.

The invention will now be described in more detail with reference made to the accompanying drawings, in which:

fig. 1 shows schematically one press section for a paper machine of the prior art, including a wire and drying section associated therewith.

Fig. 2 shows a schematic basic view of one suction roll of the prior art in a longitudinal section.

Fig. 3 shows another suction roll of the prior art in a schematic cross-section,

fig. 4 shows one embodiment for a suction roll shell of the invention in a schematic longitudinal section,

fig. 5 shows a second embodiment for a suction roll shell of the invention in a schematic longitudinal section, and

fig. 6 shows the embodiment of fig. 5 in a further development.

Fig. 7 shows one embodiment for a deflection-compensated roll of the invention in a schematic longitudinal section.

Fig. 1 depicts a press section II, having a type of basic geometry similar to what is marketed by the Applicant under the trademark "Sym-Press II" ™ and provided with four successive dewatering press nips N_1, N_2, NP_1 and NP_2. The nips NP_1 and NP_2 are long nips, wherein the long nip zone has a machine-directed length in the order of 100...300 mm. The long nip zone NP_1 and NP_2 has a machine-directed length which is about (3...10) x the respective length of the roll nips N_1 and N_2. Naturally, the same relationship applies also to press times of various nips. Furthermore, in wider machines (width ≥ 4,5 m), the middle roll of the press section comprises usually a deflection compensated roll 20, which may be heatable.

As shown in fig. 1, a paper web W is removed over a suction zone 11a of a pick-up roll 11 from a wire section's I forming wire 10, which travels over a suction roll 60, and is carried on the bottom surface of a press section's II pick-up felt 12 to a first roll nip N_1. The first roll nip N_1 is double-felted and provides a passage, in addition to the pick-up felt 12, for a water take-up bottom felt 15 guided by guide rolls 16. The bottom roll of the press nip N_1 comprises e.g. a press roll 14 provided with a grooved surface 14' and its top roll comprises a suction press roll 13 provided with two successive suction zones 13a and 13b. In the nip N_1, dewatering occurs in two directions into the felts 12 and 15 through both surfaces of the web. The suction press roll 13 is provided with a perforated shell and over its first suction zone 13a the pick-up felt 12, and the web W present on its outer surface, runs curvilinearly to a second roll nip N_2, whose press zone is in line with the second suction zone 13b which is preferably provided with a higher negative pressure than the preceding zone 13a. The second roll nip N_2 develops between the aforesaid suction press roll 13 and a heated deflection-compensated middle roll 20. Associated with the suction zone 13a of the suction roll 13, in close proximity of the outer surface of the web W is a steam box 34 for raising the level of web temperature upstream of the second roll nip N_2 and before the web is brought into contact with the heated shell surface of the hot roll 20. In line with

the nip N_2, the middle roll 20 can be provided with intra-roll implements for regulating the lateral compression pressure profile of the roll nip N_2 and for controlling the flattening and deflection of the shell of the middle roll 20 caused by the roll nip N_2.

Downstream of the roll nip N_2, the web W follows the smooth surface of the middle roll 20 to a third press nip, which is a long nip NP_1.

Downstream of the long nip zone NP_1, the web W follows the smooth surface of the heated middle roll 20 and is delivered, assisted by a suction zone 51a of a suction transfer roll 51, to a bottom felt 50, on whose top surface the web W is carried to a second long nip N_2, whose bottom roll comprises a long nip roll 56A provided with a belt shell 56a and with a loading shoe assembly 59 for regulating a lateral pressure profile and controlling the deflection. In this press concept, the top roll of the long nip NP_2 comprises a suction roll 55, from which the web W is carried to a transfer roll 46 and further onto a drier section's III drying wire 40. The suction roll 55 could be replaced with a deflection compensated roll.

Fig. 2 depicts in principle one suction roll of the prior art. The suction roll comprises a roll shell 111 which is rotatably journalled on axle journals 113A and 113B connected by way of end flanges 112A and 112B to the roll shell 111. The roll shell 111 is provided with a perforation 115, which is constituted by a plurality of holes 115 extending through the roll shell 111. The figure only shows a portion of the perforation 115 in the roll shell 111. In this case, the roll has an empty interior but the roll may also house a vacuum box for delivering the suction to a given sector of the roll shell. At least one axle journal 113B is provided with connectors leading into the roll interior for coupling an external vacuum source (not shown in the figure) therewith. The vacuum source is used for exhausting air (an arrow P_2) from the entire roll interior or from a sector constituted by the vacuum box, the equivalent amount of air (an arrow P_1) flowing inside the roll through the roll shell perforation 115. The perforation 115 in the roll shell 111 may be constituted by bores extending through the entire shell 111 with an equal diameter or the bores can be provided with chamfers at the outer surface of the

shell 111, thereby enlarging the area of the holes 115 opening into the outer surface of the shell 111. The perforation 115 in the roll shell 111 is preferably made spiral in such a way that the holes are not positioned in rows parallel to the roll axis. With this arrangement, the dewatering of the holes 115 and the subsequent air-filling of the holes can be staggered in terms of time for reducing the noise caused by this action. The holes 115 have generally a diameter of about 2 to 5 mm and the chamfers have generally a diameter of about 2 to 15 mm.

Fig. 3 depicts the presently common prior art. The vacuum box and a holder for sealings are secured rigidly to each other. Sealings 101 are loaded against a shell 102 by means of loading hose pipes 103, whereby the sealings can be pressed against the shell at an approximately constant pressure even with the vacuum box in a bent condition. Water lubrication is necessary because of a sealing pressure for reducing wear of the sealings and the inner shell surface. However, water lubrication cannot be used or it is uneconomical in those suction roll applications in which the paper or board web has already been dried (by pressing or dewatering) to a high dry content (appr. more than 35 %).

Figs. 4-6 illustrate a few embodiments of the invention in connection with a suction roll, depicting schematically only shell blanks for a suction roll without suction holes and without other elements included in a roll, such as vacuum boxes, flange axles, vacuum connectors, etc.

Fig. 4 shows one embodiment of the invention in which a suction roll shell 1 comprises axial end sections 2, between which are two segments 3 constituting an axial mid-section. Said end sections and the mid-section are welded to each other at 8. The material for the mid-section 3 may be for example an austenitic-ferritic powdered metal and the end sections may be made of a relatively less expensive duplex steel (i.e. austenitic-ferritic stainless steel produced in traditional methods, e.g. by forging, milling or casting).

In a second embodiment of the invention shown in fig. 5, the suction roll shell 1 comprises respectively end sections 2 and segments 3 constituting a mid-section, which are welded to each other at 8. In the embodiment of fig. 5, each axial section 2, 3 consists in the depthwise direction of two structural layers 4, 5 and 6, 7, respectively. The layers 4, 6 constitute a body member made e.g. by casting, milling or forging, while the layers 5, 7 are made of a powdered metal which is joined with each body member by means of an HIP process. In the illustrated embodiment, the structural layers joined by an HIP process are placed on the inner shell surface. The body material 4, 6 can be for example a duplex steel, while the structural layers 5, 7 comprise for example an austenitic-ferritic powder material. Said structural layers 5, 7 are preferably made of one and the same material, while the layers constituting the body member 4, 6 can be made of different materials, e.g. such that the body layer 6 in the mid-section 3 consists of a material which is stronger than that of the body layer 4 in the end section 2.

The number of depthwise layers in axial segments can be other than what is shown in fig. 5. For example, the axial end sections 2 can be made entirely of a body material and the mid-section 3 may be constituted by a double-layer structure made of a body material and a powdered metal. The structural layer 5, 7 affords mechanical, thermal, and chemical strength to the shell assembly. Preferably, it may be thinner than the body member, yet has a sufficient thickness for providing the assembly with the above-mentioned improvement.

The embodiment of fig. 6 only differs from that of fig. 5 in that, in the ends of segments 2 and 3 set against each other, the structural layers 5, 7 extend beyond the end surface of the body member 4, and respectively 6, onto the outer surface in order to perform the welding between end surfaces 9 of one and the same material.

Fig. 7 illustrates an application for a roll shell of the invention in a deflection compensated roll. In fig. 7, reference numeral 70 designates a deflection compensated roll and reference numeral 80 a counter roll constituting a nip N therewith. The deflection compensated roll 70 comprises a stationary roll axle 71,

upon which is rotatably fitted a roll shell 1 supported on the roll axle by means of hydraulic loading elements 77. The hydraulic loading elements 77 load the roll shell 1 in the direction of a nip plane and can be used for regulating the roll shell 1 in terms of its shape and for controlling the roll in terms of its axially directed nip profile. The hydraulic loading elements can be controllable individually or in groups of several elements. One or more rows of loading elements 78 can be adapted to work against the nip direction. As shown in the figure, the journalling of the roll 70 can be implemented by using slide bearing elements (74, 74a, 75, 76, 76a). The roll shell 1 of the invention shown in fig. 7 for a deflection-compensated roll comprises two depthwise structural layers 4, 5, whereof the layer 4 constitutes in the depicted embodiment a body member manufactured e.g. by casting, milling or forging. The inner layer 5 comprises a powdered metal layer joined with the body member 4 preferably by means of a HIP process. The material for the body member 4 may be e.g. a duplex steel while the structural layer 5 comprises e.g. an austenitic-ferritic powdered metal.

The roll of the invention is fit for use in all suction roll positions in the wire and press sections of a paper machine. A particularly preferred press embodiment is a counter roll for a long nip press, for example the roll 55 in fig. 1, as well as in all those positions on the wire and press section both in calenders and multi-roll calenders which employ deflection compensated rolls.

Naturally, the roll of the invention can also be used in all other roll positions, although the benefits of the invention will be most prominent in applications which expose the roll to a major stress.

Claims

1. A roll for a paper/board machine or a finishing or a converting machine, which is provided with a metal-constructed shell (1), characterized in that the shell (1) is designed as a composite structure, comprising in the axial direction of the shell at least two components (2, 3) manufactured respectively from a first and a second material, said first and second materials being metals different from each other in terms of the production technique and/or composition thereof, and/or in the depthwise direction of the shell, at least over a portion of the axial length of the shell, at least two layers (4, 5; 6, 7) in which the materials of a first and a second layer, respectively, are metals different from each other in terms of the production technique and/or composition thereof.

2. A roll as set forth in claim 1, characterized in that the shell (1) comprises axially directed end sections (2), manufactured from a first material, and a mid-section (3) between the end sections (2), manufactured from a second material, and that said second material, in terms of at least one of its features, is of a higher quality than said first material, said feature being optionally one of the following: strength, corrosion resistance, fatigue strength or wear resistance.

3. A roll as set forth in claim 2, characterized in that the material for the mid-section (3) of the shell (1) comprises a powdered metal and the material for the end sections (2) comprises stainless steel.

4. A roll as set forth in claim 1, characterized in that the shell includes at least one axially directed component (2, 3) comprising two layers, whereof a first material layer (4, 6) constitutes a thicker body member, having its inner and/or outer surface provided with a thinner structural layer (5, 7) which affords desired further structural features and comprises a material which is different in terms of its production technique and/or composition.

5. A roll as set forth in claim 4, characterized in that the structural layer (5, 7) comprises a powdered metal coated on the surface of the body member (4, 6) of stainless steel.

6. A roll as set forth in any of the preceding claims, characterized in that the roll comprises a suction roll provided with a perforated shell.

7. A roll as set forth in any of the preceding claims, characterized in that the roll comprises a deflection-compensated roll, especially a press roll or a calender roll or a breast roll.

8. A roll as set forth in any of the preceding claims, characterized in that the roll comprises a counter roll for a long nip press.

9. A method for manufacturing a roll shell for a paper/board or finishing machine, characterized by manufacturing at least two components (2, 3) in the axial direction of the shell from a first and a second material, respectively, said materials being metals different from each other in terms of the production technique and/or composition thereof, and by assembling into a roll shell by connecting the components (2, 3) together at the ends thereof.

10. A method as set forth in claim 9, characterized in that the components (2, 3) are connected together by welding.

11. A method as set forth in claim 9 or 10, characterized in that the component (2) of the first material is manufactured by forging, milling or casting, and the component (3) of the second material is manufactured powder metallurgically.

12. A method for manufacturing a roll shell for a paper/board or finishing machine, characterized by manufacturing at least one axial component (3) from a first material (6) and providing its inner and/or outer surface with a structural layer (7) of a second material, said materials being metals different from each other in terms of the production technique and/or composition thereof.

13. A method as set forth in claim 12, characterized in that the component (3) is manufactured by forging, milling or casting from a first material and its inner and/or outer surface is provided with the structural layer (7) by means of powder metallurgical processes.

14. A method as set forth in claim 13, characterized in that the structural layer (7) is formed on the inner surface of the first material (6) by means of hot isostatic pressing.

15. A method for manufacturing a suction roll shell for a paper/board machine, characterized by manufacturing an axial mid-section (3) from a first material (6) and providing its inner and/or outer surface with a structural layer (7) of a second material, as well as end sections (2) from a third material (4), whose inner and/or outer surface is optionally provided with a structural layer (5) of a fourth material, said first (6) and second (7) materials and, respectively, said third (4) and fourth (5) materials being metals different from each other in terms of the production technique and/or composition thereof, and by assembling a suction roll shell by connecting the axial mid-section (3) to the end sections (2), whereafter the shell is perforated.

16. A method as set forth in claim 15, characterized in that the second and fourth materials, respectively, which constitute the structural layer (7) and the optional structural layer (5), are made of an identical metal material.

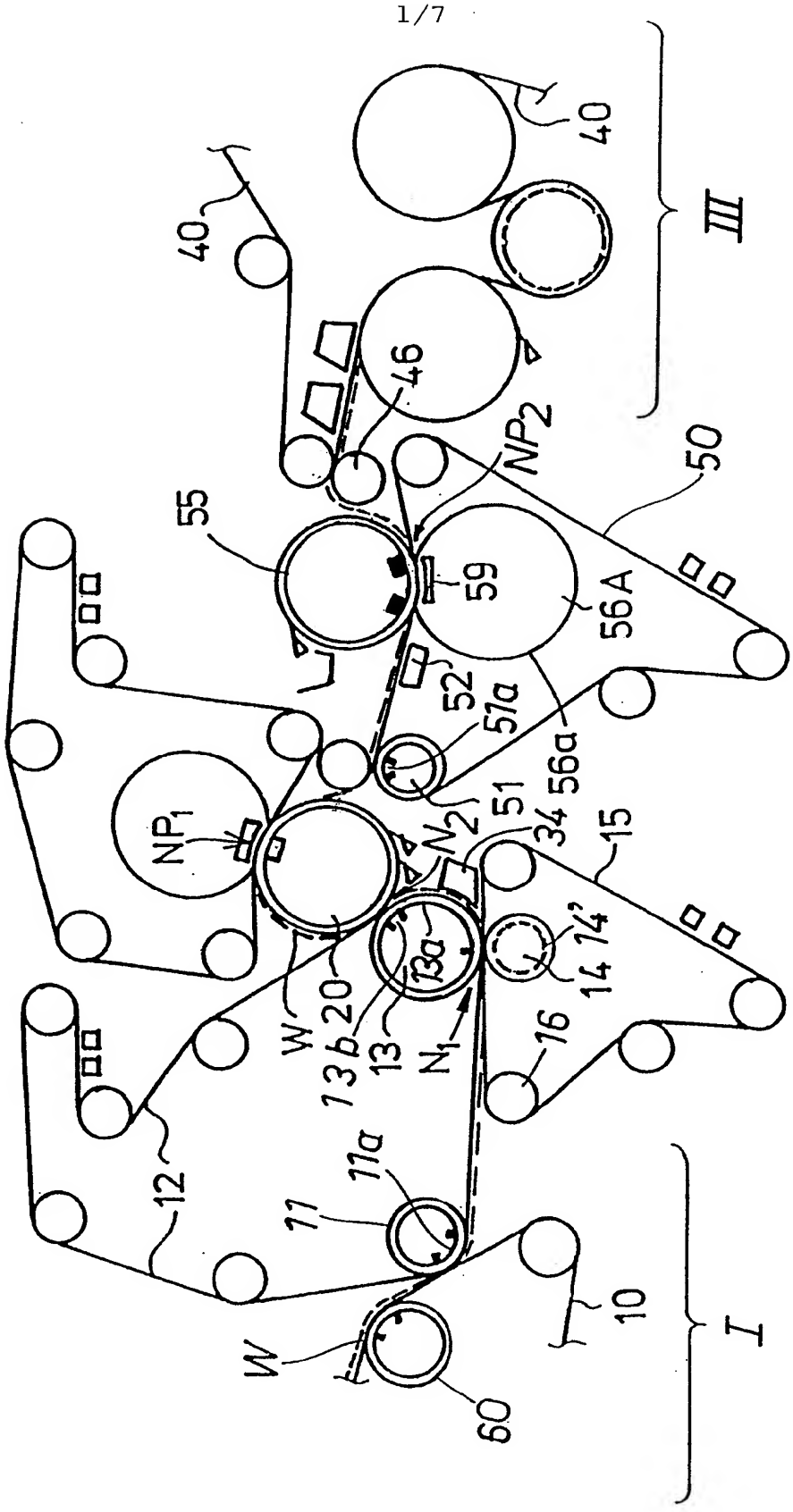
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Fig. 1

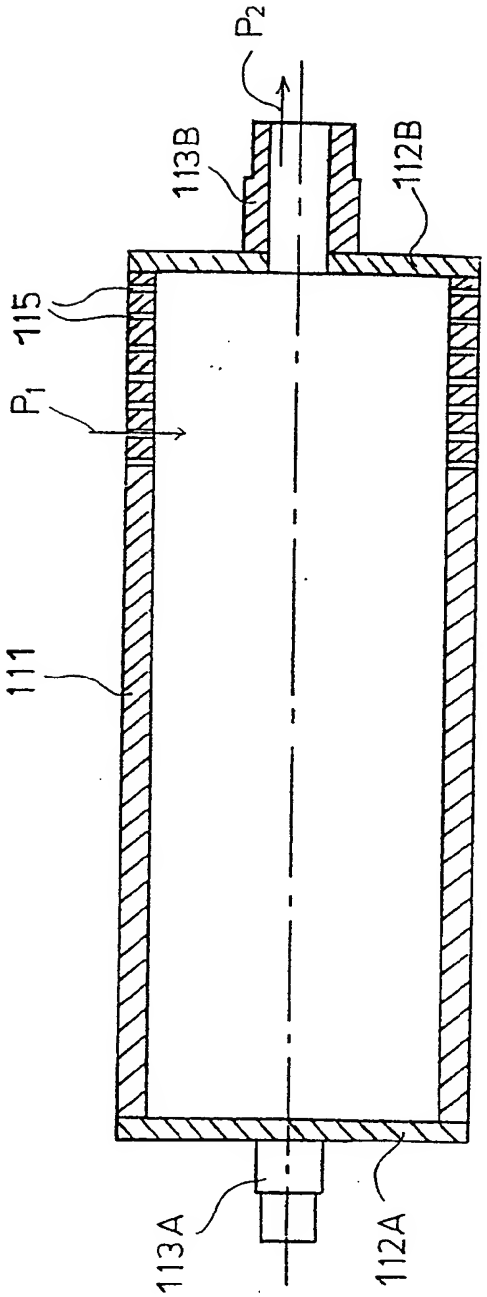

Fig. 2

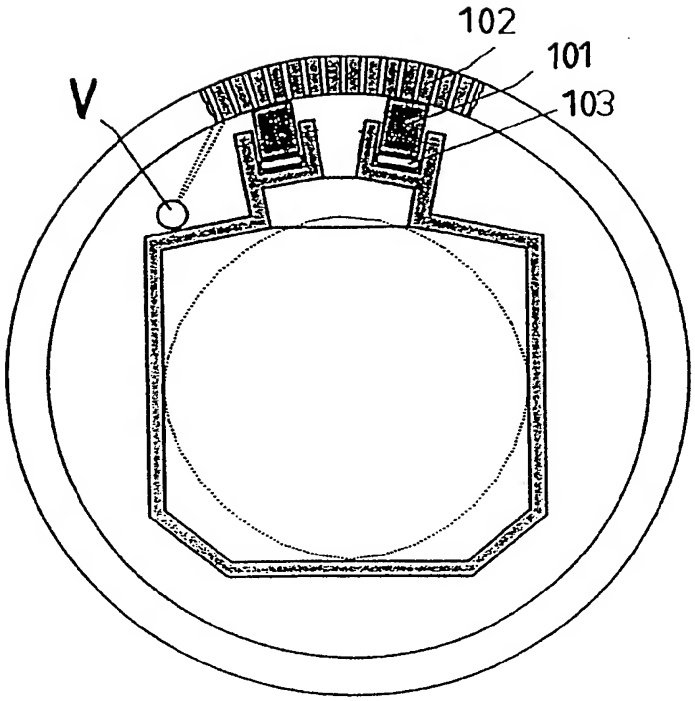

Fig. 3

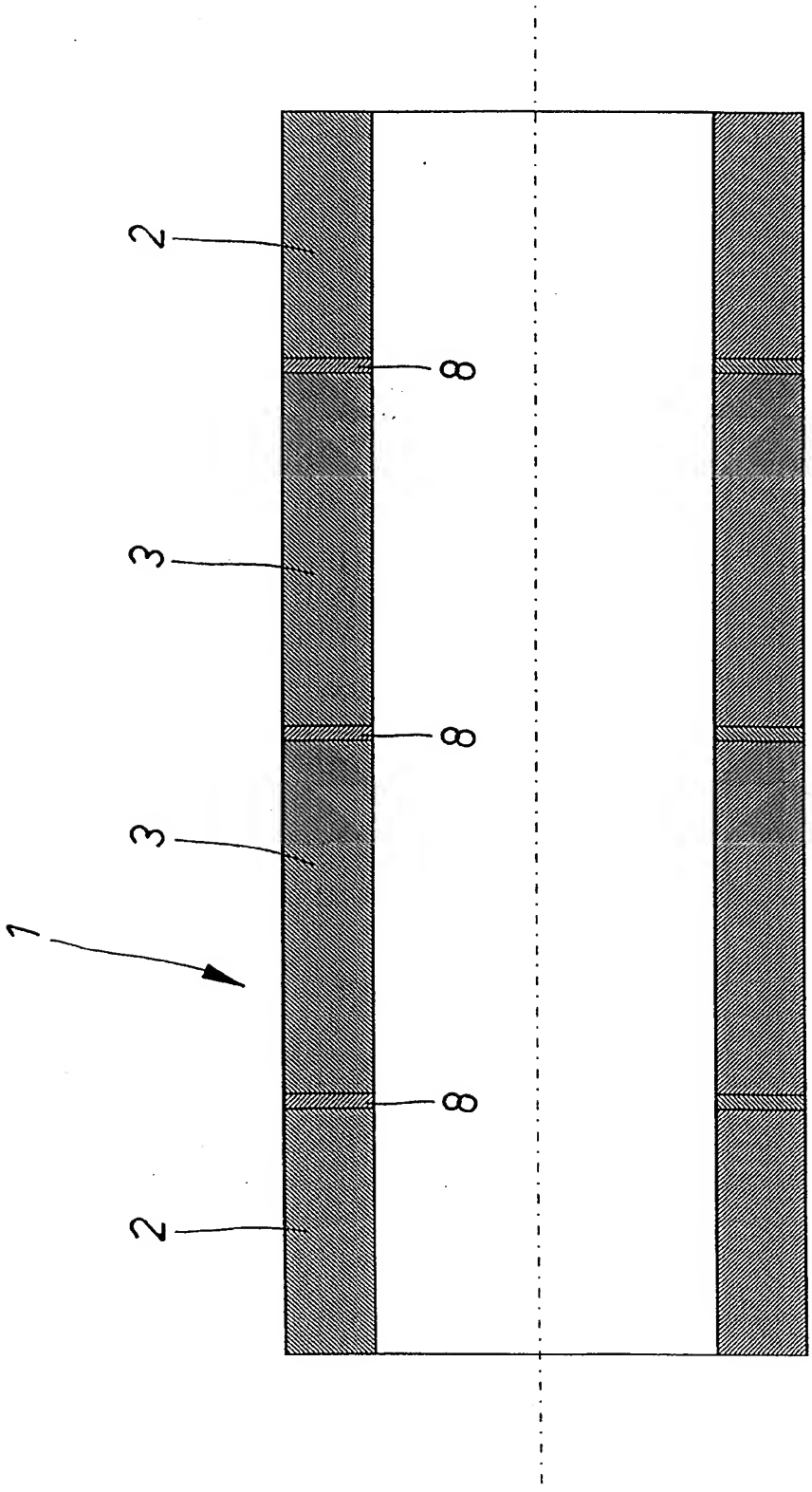

Fig. 4

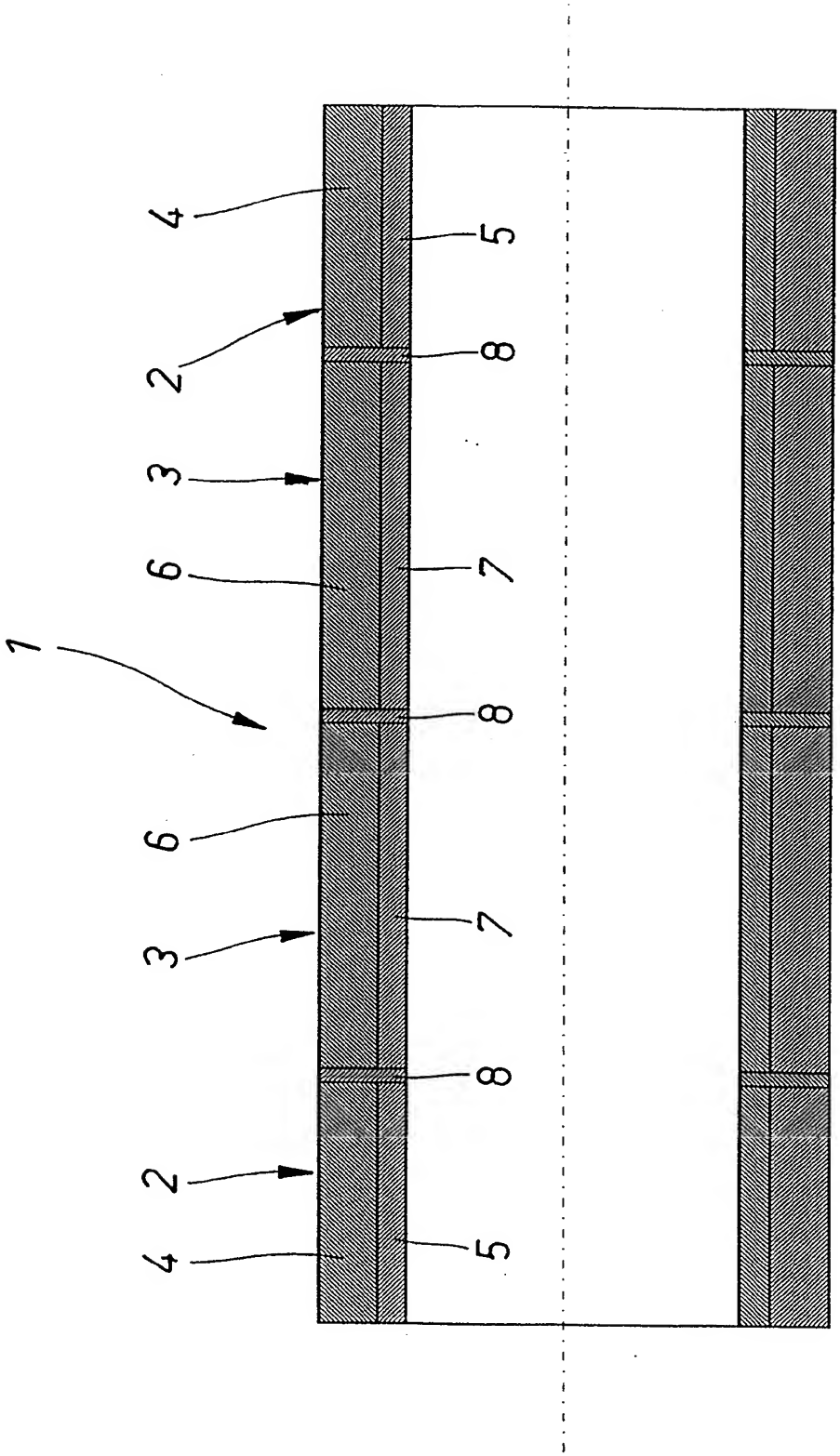

Fig. 5

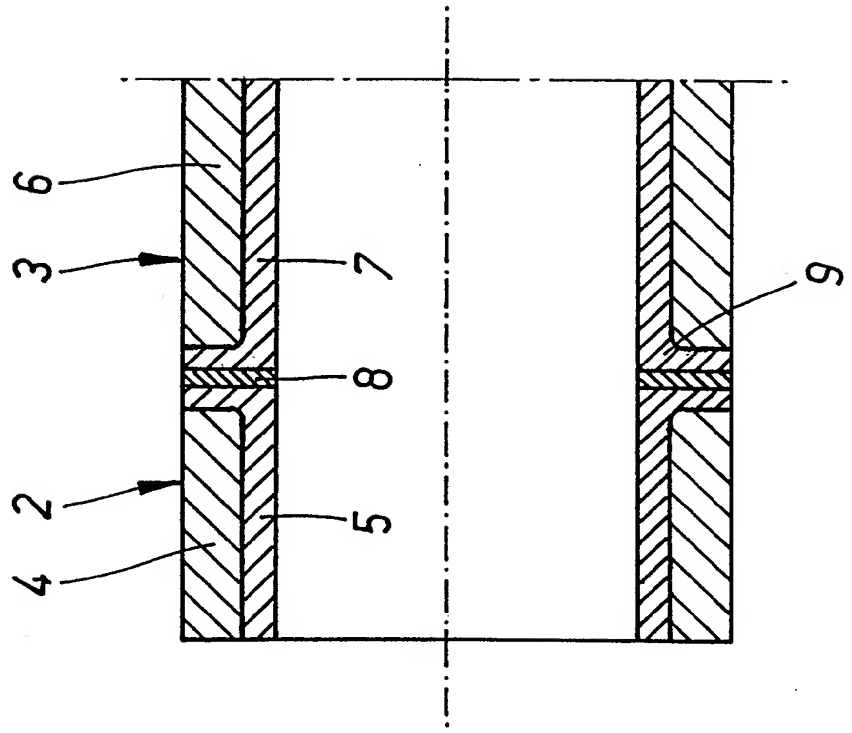

Fig. 6

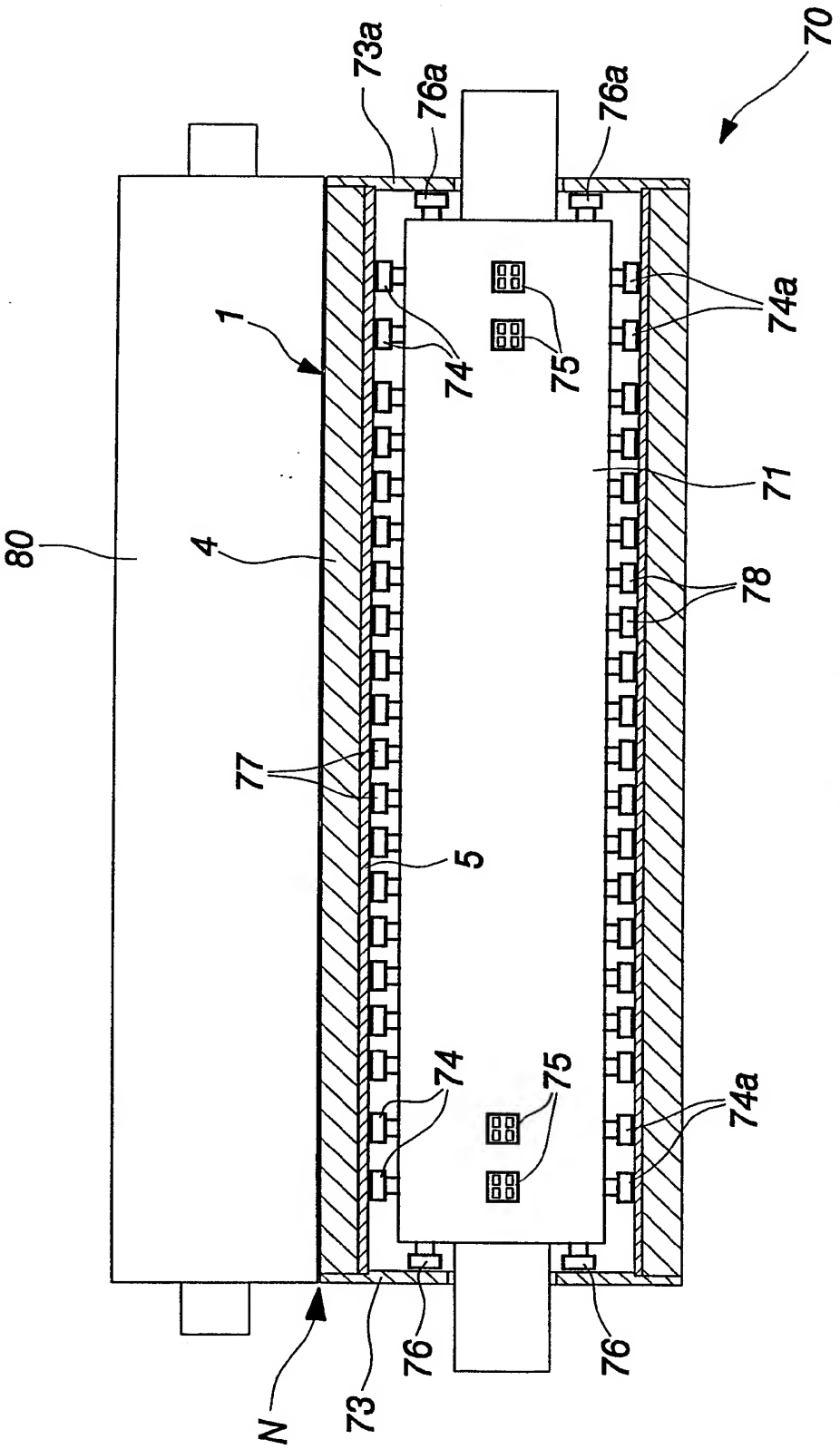

Fig.7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00407

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: D21F 3/08, D21F 3/10, F16C 13/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: D21F, F16C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DIALOG: ALLSCIENCE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 3082790 A (KUBOTA CORP) 8 April 1991 (abstract) World Patents Index (online). London, U.K.: Derwent Publications, Ltd. (retrieved on 1999-09-02). Retrieved from: EPO WPI Database. DW 9120, Accession No. 91-145597; & JP 3082790 (KUBOTA CORP) 26 June 1991 (abstract) (online)(retrieved on 1999-09-02). Retrieved from: EPO PAJ Database; & JP 3-82790 A (KUBOTA CORP) 8 April 1991	1,9
A	EP 0603749 A1 (HITACHI METALS, LTD.), 29 June 1994 (29.06.94)	1,9
A	EP 0560210 A1 (HITACHI METALS, LTD.), 15 Sept 1993 (15.09.93)	1,9

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 Sept 1999	07 -09- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Olov Jensén/ELY Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00407

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0525932 A1 (HITACHI METALS, LTD.), 3 February 1993 (03.02.93) -- --------	1,9

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/08/99

International application No.
PCT/FI 99/00407

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